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IS : 7895 - 1975

Indian Standard

TESTS FOR FIRE-RESISTANT CHARACTERISTICS OF HYDRAULIC FLUIDS USED IN MINING MACHINERY

(First Reprint JULY 1983)

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

TESTS FOR FIRE-RESISTANT CHARACTERISTICS OF HYDRAULIC FLUIDS USED IN MINING MACHINERY

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Indian Standard

TESTS FOR FIRE-RESISTANT CHARACTERISTICS OF HYDRAULIC FLUIDS USED IN MINING MACHINERY

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 18 August 1975, after the draft finalized by the Lubricants and Related Products Sectional Committee had been approved by the Chemical Division Council and the Mechanical Engineering Division Council.

0.2 Conventional petroleum oils and synthetic fluids used as hydraulic fluids in mining machinery present a fire hazard when leakage or line-rupture takes place exposing the fluid to a source of ignition. The fire hazard is most serious in underground locations particularly in coal mines. Stringent specifications of mandatory nature exist in most countries limiting the use of hydraulic fluids in underground machinery to only those possessing approved fire-resistant characteristics.

0.3 The mining industry in India is being increasingly mechanized and this will lead to more widespread use of hydraulic fluids. In view of the high priority to be given to safety aspects in mining operations, the Director General of Mines Safety (DGMS) made a request for the preparation of this standard.

0.4 It is envisaged that the Director General of Mines Safety would be the approving authority for qualifying hydraulic fluids as fire-resistant. The Central Mining Research Station, Dhanbad and the Indian Institute of Petroleum, Dehra Dun are expected to provide the necessary testing and evaluation facilities and assist Director General of Mines Safety in its approval function.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (revised).

1. SCOPE

1.1 This standard prescribes the test requirements for fire-resistant characteristics, and methods of sampling, of hydraulic fluids used in mining machinery. It does not cover the physical properties of fluids such as viscosity, flash point, pour point, water content, etc, nor does it lay down performance requirements on characteristics such as lubricity, resistance to water, extreme-pressure property, effect on packings and seals, etc.

1.2 It is emphasized that the suitability of fluids for any particular application should be assessed and agreed upon by consent between the equipment manufacturers, fluid suppliers and users. Assistance in this regard may be obtained from 'Indian Standard Code of practice for selection and use of fire-resistant hydraulic fluids in mining machinery' (*under preparation*).

2. TYPES

2.1 The fire-resistant fluids covered by this standard shall belong to one of the following types:

- a) Water-in-oil emulsions,
- b) Water-glycol fluids, and
- c) Non-aqueous or synthetic fluids.

3. REQUIREMENTS

3.1 Fire-Resistant Characteristics — The fluid shall be qualified as fire-resistant under this standard provided it shall satisfactorily meet the requirements of the following tests:

- a) Autogenous-ignition temperature test as described in Appendix A,
- b) Temperature-pressure spray-ignition test as described in Appendix B, and
- c) Flame propagation test in a mixture of the fluid and coal dust as described in Appendix C.

3.2 Qualification Approval

3.2.1 Qualification approval shall be granted for completely compounded or mixed fluids. Approvals shall also be given for concentrates, namely, substances in concentrated form that might not be fire-resistant by themselves but when mixed with water or other medium in accordance with the instructions issued by the supplier shall constitute fire-resistant hydraulic fluids. At the time of making supply of such concentrates, the supplier shall clearly indicate to the buyer that the qualification approval is valid only when the concentrates are used in exact conformance to his instructions.

3.2.2 A 20 litre sample of the hydraulic fluid shall be provided by the supplier to the approval authorities for qualification purpose. In case of concentrate, the sample shall be in a quantity necessary to make a 20 litre sample of fluid when mixed with water or other medium according to supplier's instructions. The supplier shall undertake to pay the testing fees in terms prescribed by the testing laboratories.

3.2.3 At the time of submitting sample for qualification approval, the product supplier shall provide the following data on his product to the approval authorities:

- a) Viscosity,
- b) Pour point,
- c) Flash point (only in case of non-aqueous or synthetic fluid),
- d) Water content, and
- e) Inorganic elemental analysis.

3.2.4 The qualification authorities reserve the right to rescind for cause, any time, any certificate approval granted under this standard.

4. PACKING AND MARKING

4.1 Packing — The material shall be packed in containers of metal or any other suitable material as agreed to between the purchaser and the supplier.

4.2 Marking — The containers shall be securely closed and marked with the name, type and mass of the material; name of manufacturer, recognized trade-mark, if any; and identification in code or otherwise to enable the lot of consignment or manufacture to be traced back.

4.2.1 The containers may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard, under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

5. SAMPLING

5.1 Representative samples of the material shall be drawn as prescribed in IS : 1447-1966*.

*Methods of sampling of petroleum and its products.

APPENDIX A

[Clause 3.1(a)]

AUTOGENOUS-IGNITION TEMPERATURE TEST

*(Adapted from US Bureau of Mines Document Schedule 30,
Title 30-Mineral Resources Approved on 11 December 1959)*

A-1. OBJECT

A-1.1 The object of this test is to determine the lowest autogenous-ignition temperature of a hydraulic fluid at atmospheric pressure when using the syringe-injection method.

A-2. DESCRIPTION OF APPARATUS

A-2.1 Test Flask — The test flask, which is heated and into which the test sample is injected, shall be a commercial 200-ml borosilicate glass Erlenmeyer flask.

A-2.2 Thermocouples — Calibrated thermocouples (iron-constantan or chrome-alumel) and a potentiometer shall be used for all temperature measurements.

A-2.3 Syringe — A hypodermic syringe (0.25 or 1 ml capacity) equipped with a 5 cm No. 18 stainless steel needle and calibrated in hundredths of a cubic centimetre (0.01 ml) shall be used to inject samples into the heated test flask.

A-2.4 Timer — An electric timer or stop-watch calibrated in not more than 0.2 second intervals shall be used to determine the time lag before ignition. Time lag is the time that elapses between the instant of injection and that of ignition of the test sample, as evidenced by flame.

A-2.5 Furnace — The furnace in which the ignition temperature test is conducted shall consist of refractory (alundum or equivalent) cylinder about 120 mm in internal diameter and 120 mm in height; a suitable ring top and a disc bottom of suitable material (such as transite) each of which is attached to a metal cylinder. The furnace is heated by three elements as follows:

- a) A circumferential heater embedded in the refractory cylinder;
- b) A top or toroidal-neck heater that surrounds the neck of the test flask; and
- c) A flat base heater on which the test flask rests.

A-2.5.1 The temperature of each heating element shall be controlled independently by an autotransformer. Means shall be provided for applying thermocouples at the neck, mid-section, and base of the test flask, which shall be inserted upright in the furnace.

A-3. PROCEDURE

A-3.1 Temperature Control — Each autotransformer shall be so adjusted that the temperature at the neck, mid-section, and base of the test flask is uniform within $\pm 1^{\circ}\text{C}$ of the desired test temperature.

A-3.2 Sample Injection and Timing — A 0.07 ml test sample shall be injected into the heated test flask with the hypodermic syringe, and the syringe shall be withdrawn immediately. Measurement of time shall start from the instant the sample is injected.

A-3.3 Observations

- a) If flame does not result in 5 minutes or more after injection of the test sample, the sample shall be considered non-flammable at the test temperature, and the timer shall be stopped. The test flask shall then be flushed well with clean dry air and, after a lapse of 15 minutes or more, the test shall be repeated with the test flask temperature raised by $28 \pm 1^{\circ}\text{C}$ above the first test temperature.
- b) If ignition (flame) is observed in 5 minutes or less after the injection of the test sample (0.07 ml), the time lag (time interval) shall be noted. After an ignition occurs the temperature of the test flask shall be reduced by 3°C , and the test procedure repeated in decrements of 3°C until ignition no longer occurs and this temperature shall be noted as the first non-ignition test temperature for the 0.07 ml sample.
- c) The temperature shall be increased by $28 \pm 1^{\circ}\text{C}$ above the first non-ignition test temperature and the ignition temperature test procedure shall be repeated with a 0.10 ml test sample injected into the heated test flask.
- d) If the lowest temperature at which ignition occurs with the 0.10 ml sample (in decrements of 3°C) is lower than that obtained with the 0.07 ml sample, the ignition temperature test procedure shall be repeated using a test sample of 0.12 ml, then 0.15 ml, and so on by increments of 0.03 ml until the lowest ignition temperature is obtained.
- e) If the lowest temperature at which ignition is obtained with the 0.10 ml sample is greater than that obtained with the 0.07 ml sample, the ignition temperature test procedure shall be repeated by reducing the test sample to 0.07 ml and then to 0.03 ml until the lowest ignition temperature is obtained.

A-4. APPRAISAL OF TEST

A-4.1 A fluid shall be considered fire-resistant, according to the requirements of this test, provided that in no instant of the test procedure the ignition temperature of the test sample is less than 315°C.

APPENDIX B

[Clause 3.1(b)]

TEMPERATURE-PRESSURE SPRAY-IGNITION TEST

*(Adapted from US Bureau of Mines Document Schedule 30,
Title 30-Mineral Resources Approved on 11 December 1959)*

B-1. OBJECT

B-1.1 The object of this test is to determine the flammability of a hydraulic fluid when it is sprayed over three different sources of ignition as described under **B-2.4**.

B-2. DESCRIPTION OF APPARATUS

B-2.1 A 3-litre pressure vessel, with the necessary connections, valves, and heating elements, shall be used for containing and heating the fluid under the test conditions as specified in **B-3**.

B-2.2 An atomizing round spray nozzle, having a discharge orifice of 0.625 mm diameter, capable of discharging 12.5 litres of water per hour with a spray angle of 90 degrees at a pressure of 7 kgf/cm² (686 kN/m²) shall be connected to the pressure vessel.

B-2.3 A commercial pressurized cylinder, containing nitrogen with the customary regulators, valves, tubing, and connectors, shall be used to supply nitrogen to the pressure vessel described in **B-2.1**.

B-2.4 Three igniting devices shall provide three different sources of ignition as follows:

- a) A metal trough in which cotton waste soaked in kerosine is ignited,
- b) An electrical arcing device or a spark generator operating at 12 000 volts and minimum current of 0.03 amperes, and
- c) A LPG torch.

B-2.5 A means of measuring distances from the nozzle tip to the igniting device shall be provided.

B-3. PROCEDURE

B-3.1 A 2.5 litre sample of the fluid shall be poured into the pressure vessel and heated to a temperature of 65°C. The temperature shall be maintained at not less than 62.5°C nor more than 67.5°C during the test.

B-3.2 Nitrogen shall be introduced into the vessel at 10.5 kgf/cm² (1 029 kN/m²).

B-3.3 The fluid shall be sprayed at each igniting device, described in **B-2.4**, which is moved along the trajectory of the spray. Each igniting device shall be held in the spray at different distances from the nozzle tip for one minute or until the flame or arc is extinguished (if less than one minute) to determine the fire-resistant characteristic of the fluid.

B-4. APPRAISAL OF TEST

B-4.1 If the test procedure as described above does not result in an ignition of any sample of fluid or if an ignition of a sample does not result in flame propagation for a time interval not exceeding 6 seconds at a distance of 450 mm or more from the nozzle tip to the centre of each igniting device, it shall be considered fire-resistant according to the requirements of this test method.

APPENDIX C

[Clause 3.1(c)]

FLAME-PROPAGATION TEST IN A MIXTURE OF THE FLUID AND COAL DUST

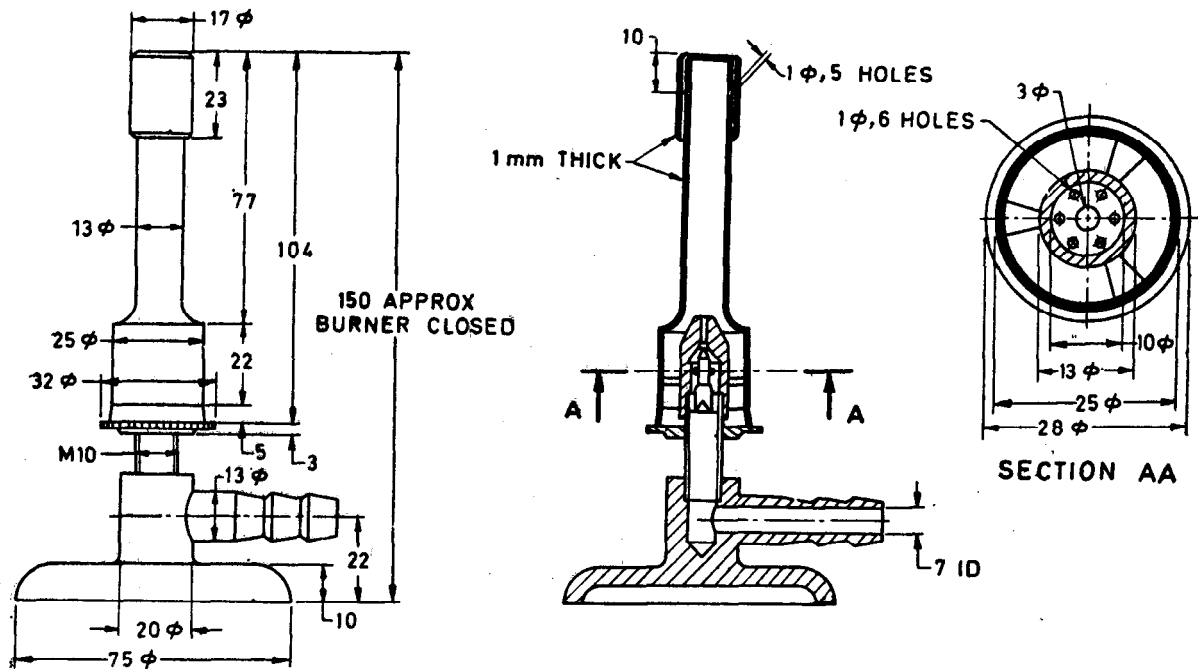
(Adapted from Report of Mines Safety Commission of the European Economic Community Published on 26 March 1971)

C-1. OBJECT

C-1.1 The propagation of a flame is measured in a mixture of 75 g of coal dust and 37.5 ml of fluid. The test is carried out in an enclosure at ambient temperature without artificial ventilation.

C-2. DESCRIPTION OF APPARATUS

C-2.1 Standard propane gas burner with control for both air and gas, as shown in Fig. 1.

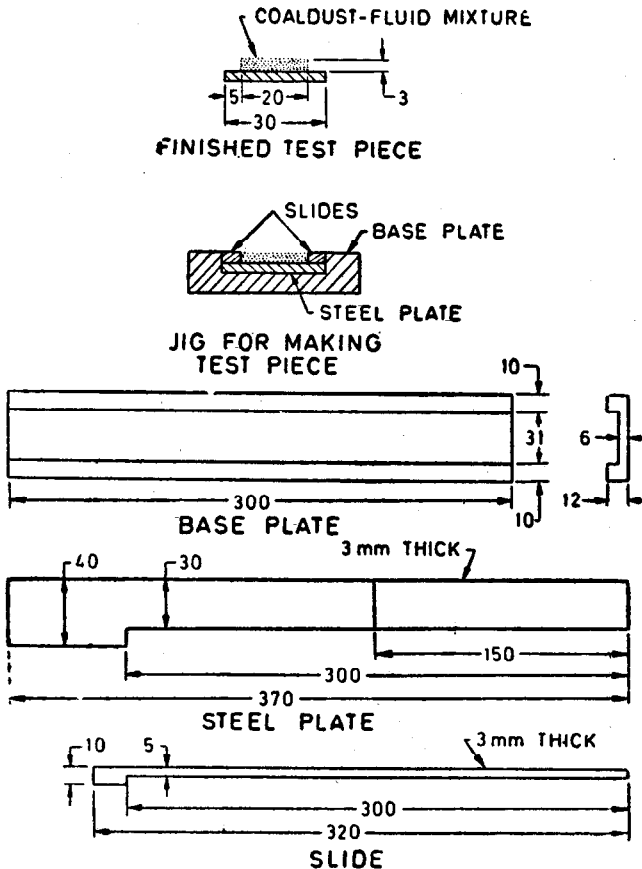


All dimensions in millimetres.

FIG. 1 BURNER FOR FLAME PROPAGATION TEST APPARATUS

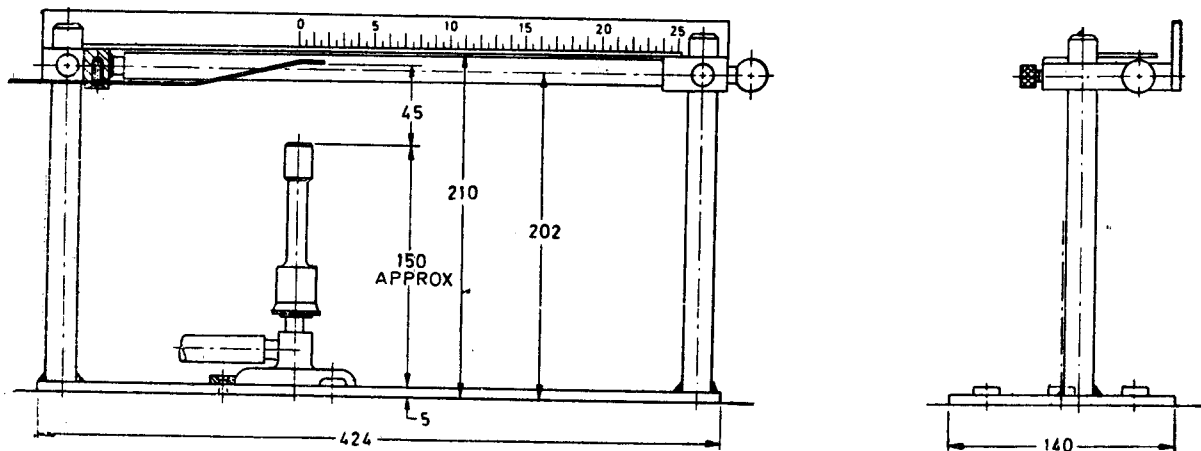
C-2.2 LPG cylinder not emptied of more than 80 percent by mass of gas contained in it, fitted with pressure reducing valve.

C-2.3 Standard base plate with mounts for various parts of the test apparatus (support for the test piece plate, support for the thermocouples and support for the graduated scale) and test piece plate as shown in Fig. 2 and 3.



All dimensions in millimetres.

FIG. 2 MAKING OF TEST PIECE



All dimensions in millimetres.

FIG. 3 TEST FOR FLAME PROPAGATION IN COAL DUST-FLUID MIXTURE

C-2.4 Porcelain mortar and glass or porcelain pestle weighing about 200 g.

C-2.5 Other usual laboratory accessories like timer, pyrometer, graduated scale, manometer, rotameter, watch-glass, etc.

C-3. COAL DUST

C-3.1 The coal dust used for the test, its preparation and supply shall be standardized by the qualification authority. The average characteristics of this dust are as follows:

Moisture	1.3 percent (tolerance \pm 20 percent)
Ash, dry basis	13.7 percent (tolerance \pm 10 percent)
Volatile matter, dry basis	22.7 percent (tolerance \pm 10 percent)
Particle size	0 to 100 micron

C-4. PREPARATION OF THE TEST MIXTURE

C-4.1 The test mixture shall be in proportion of 75 g coal dust to 37.5 ml of the fluid to be tested. Two mixtures are prepared, each in quantity sufficient for 10 determinations. In principle a porcelain mortar and a glass or porcelain pestle should be used. First, all the coal dust is placed in the mortar, then the fluid is gradually added while the contents are stirred. The mixture should be stirred for 15 minutes. Each test mixture is covered by a watch-glass.

C-5. PREPARATION OF THE TEST PIECE

C-5.1 An interval of one hour should be allowed between completing the test mixture and beginning the preparation of the test pieces. Before starting the latter, the test mixture shall be stirred once again. The test piece is at least 150 mm long and 20 mm thick. The test piece plates bear a datum mark 150 mm from the end to indicate the starting point of the test piece. The lateral clearances are obtained by means of slides. Ten pieces are produced from each test mixture. In preparing the test piece, care shall be taken to press the paste uniformly.

C-6. PROCEDURE

C-6.1 The gas pressure is set at 650 mm H₂O (6.37 kN/m²) and its flow at 26 l/h corresponding to 60 divisions of the rotameter scale. The air intake is adjusted so that the free height of the flame is about 140 mm and that of its blue cone approximately 35 mm. Under these conditions, the temperature of the flame, measured 5 mm below an empty sheet steel plate, is $1\,000 \pm 30^{\circ}\text{C}$. The various adjustment rings are locked in position by suitable means. The adjustments are checked before the test, half an hour after the burner is first lit. The empty steel plate is then replaced by the test piece plate.

C-6.2 The centre of the burner is positioned vertically below the point of origin of the test piece, as shown in Fig. 3. The tip of the burner is 45 mm away from the under surface of the steel plate. A timer is started as soon as the steel plate is fitted, and after a heating period of 5 minutes, the burner is removed. The following are noted:

- a) The farthest distance in mm travelled by the tip of the flame;
- b) The time taken for the flame on the test piece to die out; and
- c) Any anomalies, that is, glowing after extinction of the flame, extinction followed by renewed ignition, etc.

C-6.3 Each test with a given fluid consists of 2×10 measurements, each test piece being used only once. The steel plates for the test piece are refurbished by scrapping and cooling. The remaining traces are removed by scrapping with an abrasive cloth of suitable grade. After ten determinations, it is advisable to renew the datum mark on each support by means of a metal scriber.

C-7. APPRAISAL OF TEST

C-7.1 The result is expressed as the arithmetic mean of the 10 distances measured in mm for each of the two mixtures. If the difference between the means does not exceed 10 mm, the final result shall be the mean of both results. In the opposite case, a third test consisting of 10 determinations shall be carried out with a new mixture. The flame shall not spread beyond the field of action of the burner flame by an arithmetic mean value (of the two sets of 10 measurements) of 100 mm, 95 percent of the individual measurements being 130 mm or less.

(Continued from page 2)

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Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s ²
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m ²
Frequency	hertz	Hz	1 Hz = 1 c/s (s ⁻¹)
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m ²

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